

natural period (T_0) this energy (except for the loss in extending the muscles and in the ground) is conserved by the action of gravity.

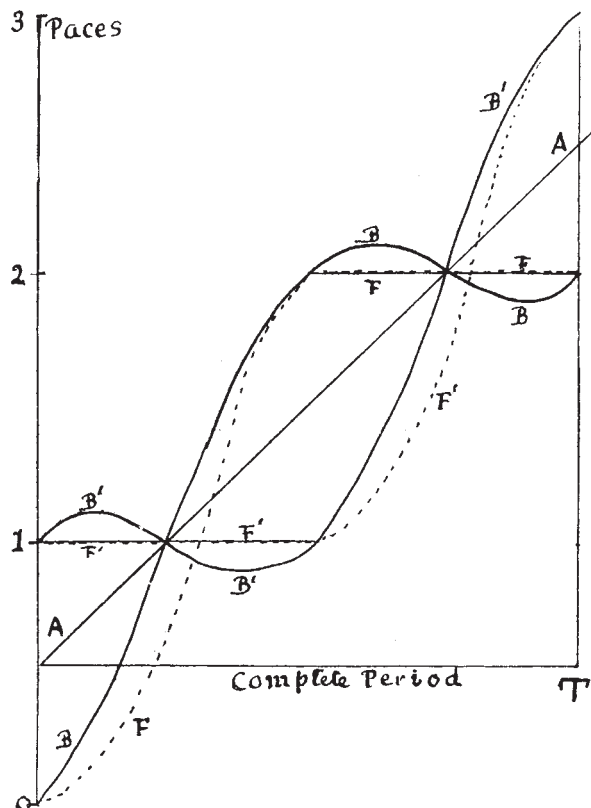


FIG. 1.—AA, motion of body (assumed uniform); BB, trace on ground of right femur (produced); B'B', trace on gr. und of left femur (produced); FF, position of right foot; F'F', position of left foot.

For any other period (T_1) an amount of energy equal to

$$2\pi^2 ma^2 \left(\frac{1}{T_1^2} - \frac{1}{T_0^2} \right)$$

has to be expended four times in each pace, twice for acceleration and twice for retardation.

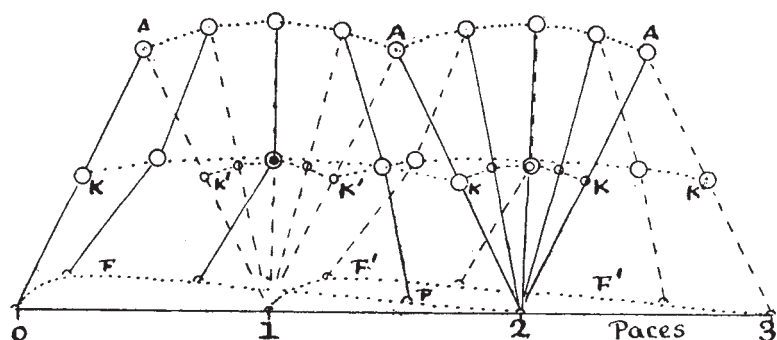


FIG. 2.—AA, positions of hip joints; KK, positions of right knee; K'K', positions of left knee; FF, positions of right foot; F'F', positions of left foot.

Thus for both legs, in each complete period, the amount of energy to be supplied by the muscles is

$$8\pi^2 ma^2 \left(\frac{1}{T_1^2} - \frac{1}{T_0^2} \right),$$

and the power required is

$$\frac{8\pi^2 ma^2}{T_1} \left(\frac{1}{T_1^2} - \frac{1}{T_0^2} \right)$$

If $P - Ca$ is the maximum power available (where Ca represents loss from muscular extension), then—

$$\frac{P - Ca}{8\pi^2 ma^2} = \frac{1}{T_1} \left(\frac{1}{T_1^2} - \frac{1}{T_0^2} \right),$$

or, putting $T_1 = pT_0$,

$$T_0^3 \frac{P - Ca}{8\pi^2 ma^2} = \frac{1 - p^2}{p^3}.$$

As a numerical example, assume that $P - Ca$ is 1/10 h.p., or 55 ft.-lb. per sec., also that (as given above) $T_0 = 1.35$ sec.

The weight of each leg is about 30 lb. (so that $m = 1$ nearly). The length of the leg being 3 ft., and that of the pendulum of 1.35 sec. period 1.48 ft., then, since each half pace = 1.5 ft., $a/1.5 = 1.48/3$, or $a = 0.74$ ft. nearly.

$$\text{Thus } T_0^3 \frac{P - Ca}{8\pi^2 ma^2} = 2.46 \frac{55}{79 \times 0.55} = 3 \text{ nearly,}$$

whence $p = 0.6$ nearly.

Thus the speed of walking at which 1/10 h.p. is consumed in acceleration would be about 5 miles per hour, or rather more.

This is on the assumption that all the conditions can be represented by one simple harmonic term.

The actual motions in walking, however, are represented in Figs. 1 and 2, and some work must be done in bending the knee joint. The details of this motion vary considerably in different individuals, but in all cases the work required would reduce the maximum walking speed to something a little under 5 miles per hour, which, as a fact, is about the limit for hard walking.

Although the above estimate rests on nothing except common knowledge and casual observation, the result gives a high probability to the assumption that muscular inefficiency, *i.e.* the loss of work in accelerating and retarding their own masses, sets the limit to the speed at which they can be worked.

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Gravitation and Thermodynamics.

DR. TODD (NATURE, March 1) suggests that when one gravitative mass approaches another it acquires heat. This might occur when, as is usually (but not always) the case, the body moves up the gradient of potential; for then the energy of field displaced by the body would increase.

There is one development of the above speculation which is not explicitly mentioned by "J. L." (NATURE, March 15), though it may have been inferred. Suppose two cases: (a) A metal disc is in a vertical plane at the earth's surface. If it be started spinning on a horizontal axis through its centre the descending half warms and expands, the ascending half cools and contracts, there will arise a turning moment, and the disc will now continue to spin of itself provided the friction is small enough. (b) The extreme top and the extreme

bottom of the disc will be cold and hot points respectively, so that if metal brushes be applied there, we

¹ In the diagram, for the sake of simplicity, the motion of the body is taken as being uniform. This is not strictly correct, but the difference from uniformity is small.

could obtain a continuous current in a closed circuit. These are two cases of perpetual motion. The principle of conservation of energy which is here apparently violated is inapplicable to such cases where the forces are so much smaller than any experimental results on which that principle rests.

The temperature effect of gravitation is a residual effect of gravitation which is itself apparently a residual effect so that we are dealing with forces of, say, 10^{-12} dyne.

The fact that the forces involved in the above suggested cases (a) and (b) are far too small to render any perpetual effects observable, of course does not affect the argument, which is that the speculation does involve a theoretical continuous motion.

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Talbot's Observations on Fused Nitre.

SOME years ago in studying the position of the *solidus* curve in the binary system consisting of the nitrates of potassium and sodium, the present writer became well acquainted with the phenomena referred to by Lord Rayleigh in his interesting letter in NATURE of February 1. A number of photomicrographs were made of thin layers of the nitrates, crystallised from fusion, between crossed Nicols. and it was found very necessary in the work that the exposures should be made before the secondary change, the arrival of which, as Talbot observed, is hastened by scratching, had set in. There is, of course, now no mystery as to the cause of this secondary change upon cooling in the character of the crystals first formed from the melt, for potassium nitrate is known to be dimorphous, with a transition temperature at ordinary pressure about 129° C. A considerable degree of under-cooling often occurs, and the transition, initiated at Talbot's needle-point, spreads "like a wave" if the slide be cooler than 129° , as Lord Rayleigh found using a temperature near 100° .

If Wallerant is correct in supposing that there is a third, in all circumstances metastable, crystalline variety of potassium nitrate, still further entertainment from this interesting, if old-fashioned, salt is at least possible.

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February 24

POSITION AND PROSPECTS OF PROFESSIONAL CHEMISTS.

IN August, 1914, chemists, in common with other professional men, volunteered in considerable numbers for active service with the fighting forces. Many were already attached to the Officers Training Corps of their universities, or to Territorial units—the call was the same to them as to others. The need for fit men was the first consideration, and the need for chemists, as such, in other spheres directly connected with war was not at first recognised. Offers to the War Office of scientific assistance emanating from organised bodies and from individuals were politely acknowledged and pigeon-holed for future reference in case of necessity.

We possessed, fortunately, a number of chemists acquainted with the production of explosives, but as the magnitude of the task before us became better realised a much greater demand arose for chemists to control the operations of manufacture.

In the early months of the war lists of chemists available for the service of the country were prepared by the Institute of Chemistry, the Chemical Society, and other bodies interested in chemical science, with the result that when the Ministry of Munitions called for them a ready response was forthcoming from all parts of the country, from industrial concerns and private laboratories as well as from the universities and colleges, both at home and in the Overseas Dominions. The majority of chemists with experience in the explosives industry were already engaged on war work, and arrangements were made for the training of others to take charge of operations in new factories erected in various parts of the kingdom. Additional chemists were also needed for the increasing work of the staffs of Government laboratories and factories and to control and assist in the production of war material of all kinds. For certain requirements essential to the production of armaments and munitions, for a number of drugs, for laboratory glass and porcelain ware, filter-paper and other necessities, we had hitherto been almost entirely dependent on Germany and Austria, and this state of affairs would have led to serious difficulties if our chemists had not speedily and successfully dealt with such matters. Students in college laboratories assisted, under the supervision of their professors, in the preparation of drugs and the examination of materials, or left before finishing their courses to take up positions in works. Women science graduates, mostly teachers in time of peace, obtained appointments in analytical laboratories as substitutes for chemists who had joined the forces or been transferred to war work. The demand for trained analysts and works chemists still persists, and has been accentuated by the undoubted fact that manufacturers generally are learning to appreciate more and more the value of science in industry.

In addition to the activities referred to above, mention must be made of the help rendered to the Government by leading consulting chemists, professors of chemistry, and technologists, in an advisory capacity, with regard to inventions and to offensive and defensive measures, wherein many of our best are pitted against the much-vaunted chemists of the enemy. German chemists had obviously devoted attention to the employment of scientific frightfulness in warfare which other nations, if such means had occupied the minds of their men of science at all, would have refused to believe that any civilised people would adopt. British chemists, therefore, were perforce called upon to investigate problems wholly repugnant to their inclinations and degrading to their science in order to fight the enemy with his own weapons. Much of what they have done must remain, and probably will always remain, a sealed book; but the results are shown in the well-deserved praise accorded them in the despatches of Lord French and Sir Douglas Haig.

When the Germans started using asphyxiating gases, the War Office called for volunteers with training in chemistry and formed with little diffi-